Socioeconomic determinants of regional mortality differences in Europe

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Chapter 7

Explaining new trends in male-female mortality differences: Insights from a regional trend analysis of the Netherlands

7.1 Introduction

In the summer of 1984, the Dutch government published several scenarios for the long-term developments in public health. These scenarios were intended to create a realistic insight into the range of possible and probable future health developments, so as to allow the government to formulate specific strategies for the planning and management of health care (Department of Health, 1984). The authors of the report suggested that changes in the lifestyles of men and women could, in the near future, result in the disappearance of the differences in mortality between the sexes. A continuation of the trend towards women's emancipation could lead to a situation in which the new generation of women would adopt the risk factors currently connected to male lifestyles. The consequence would be that by around the year 2000 women would have reduced their advantage in life expectancy by around 2.3 years compared to 1982. One scenario even envisaged that women might take over the lifestyle and associated risk factors that were typical of men in the period 1950-1980. With such a scenario, male life expectancy would already by the year 2000 have been one year greater than that of women.

Recent data published by the Council of Europe show that in the last two decades changes in male and female life expectancy have indeed taken place which have made these scenarios closer to the current situation than was the case at the time of publication. Although women are still expected to live longer than men, the female advantage has decreased from 6.7 years in 1984 to 5.0 years in 2000. In comparison, the decreases in the difference were less than 0.5 years in Belgium and Germany, the two neighbouring countries (Council of Europe, 2001). Several authors have related this narrowing of the mortality gap between men and women to the significant changes that, in the same period, have occurred in the lifestyle, education, family roles and employment of women (Annandale and Hunt, 2000). Nowadays, women are almost as likely as men to be employed, and among younger women, the educational level attained has converged with that of men. Changes in employment and education have been accompanied by changes in the family and household roles of women: the number of children per woman has decreased, more women remain childless, childbearing is delayed, marriage rates have decreased, divorce rates increased and women are much more likely to live in a one-adult household. The domestic division of labour has partly adapted to the changes in women's paid employment and, as a consequence, gender differences in time spent in housework have slightly decreased.

To attempt to link the changes in the position of women to changes in the sex differences in mortality, a set of hypotheses by Waldron (2000) will be taken as a starting point. These hypotheses particularly relate to gender-specific changes in smoking behaviour, paid labour participation, emancipation and gender role modernisation.

The first hypothesis stated that sex mortality ratios would be stable because many of the factors that influence mortality trends have similar effects on males and females. A good example of a potential gender-neutral factor is medical care. The remainder of the hypotheses proposed various interrelated causes of changes in sex differences in disease-related mortality.

In what might be called a "Smoking Hypothesis", Waldron suggested that the trends in gender differences in cigarette smoking have been a major cause of the trends in sex differences associated with mortality. Since the 1980s, in many countries, gender differences in smoking have decreased and this is seen as contributing to decreasing the sex differences in lung cancer and chronic obstructive pulmonary disease. For example, in the period 1970-74, 72% of the difference in life expectancy at age 35 between men and women in the Netherlands could be attributed to smoking. In 1985-89, this figure had fallen to 53% as the decline in female life expectancy due to smoking increased (Valkonen and Van Poppel, 1997).

Her third hypothesis is that decreasing gender differences in labour force participation result in decreasing sex differences in mortality. This hypothesis assumes that women who are employed experience increased mortality risks because they are exposed to occupational hazards and job stresses, and are more prone to adopt risky behaviours such as heavy drinking and smoking due to increased independence and personal income.

A related hypothesis, which Waldron called the Women's Emancipation Hypothesis, proposed that the changes in female roles and a general liberalisation of norms concerning women's behaviour have resulted in decreasing gender differences in health-related behaviour and consequently have decreased sex differences in mortality. Increased participation by women in the labour force have thus had indirect effects on women's health-related behaviour, contributing to a general shift in cultural norms and to a relaxation of restrictions on women's behaviour. A point in case is the decrease in the social disapproval of women smoking, consuming alcohol and driving.

A more general hypothesis, the Gender Roles Modernisation Hypothesis, assumes that fundamental aspects of traditional gender roles have interacted with recent changes in socioeconomic, cultural and material conditions to influence behavioural trends. To illustrate this hypothesis, Waldron refers to trends in time devoted to housework. Due to decreased childbearing, increased women's labour force participation, greater proportions of children living with only their mothers and changes in the allocation of time by parents who live with children, the gender differences in time devoted to employment and housework have decreased. However, there appears to have been little change in gender differences in time devoted to childcare, which continues to be seen as primarily the responsibility of women. A second example relates to health behaviour. Women are more likely to adopt health-related behaviours that are seen as compatible with traditional female roles. Thus, since heavy drinking may interfere with a woman's ability to meet traditional female roles in childcare and sexual restraint, women are not expected to adopt heavy drinking and therefore gender differences in heavy drinking are not expected to decrease; on the other hand, women's driving serves many functions within the family and thus one might expect to see increases in women's driving and decreases in gender differences in driving. Female road exposure will increase further when one considers the changes that accompany women integrating into the world of work and social life outside the family. Due to the disruption of traditional values and the ensuing role ambiguity, one would therefore expect a convergence over time in male and female deaths due to traffic accidents (Pampel, 2001).

Waldron's sixth and final hypothesis proposes that trends in sex differences in mortality have been influenced by multiple diverse factors (such as biological factors) in addition to the trends in health-related behaviour.

7.2 Earlier studies

Changes in the position of women in the labour market and in the household are the result of wider changes in two fundamental social processes that explain and constrain the relationships between women and men, namely the division of labour and the structures of power (Connell, 1987 in Kawachi *et al.,* 1999). The division of labour includes the segregation of labour markets, inequalities in wages and the distinction between paid and unpaid work. Power structures refer to government and business hierarchies, the regulation of sexuality and reproduction, and authority within domestic relationships. According to Kawachi *et al.,* (1999), the changing mechanisms in social control and in the distribution of resources and power are factors in determining the relationship between men and women, and the health differences between the sexes.

Tempting as it may be to link the reduction of the male/female mortality gap to the ongoing social changes in the lives of men and women in the worlds of education and work, the household and the family, leisure and consumption, it is extremely difficult to test such an hypothesis empirically. In the traditional framework of studies of the health of men and women, the importance of social change is not fully recognised and usually a rather static approach is used in which the lives of men and women are fixed in time (Annandale and Hunt, 2000). Causal analysis is hampered by data limitations and by the complexity of the multiple interacting factors which influence some causes of death, with both lagged and contemporaneous effects.

Although the changes in the role and position of men and women have affected all countries in northern and western Europe, the extent and the speed of the changes in the positions of men and women have varied considerably among regions and countries. Changes in the position of women are likely to spread more rapidly in areas which are both culturally and socially receptive to such changes. A geographic variation in, for example, female employment rates, the family and household situation and educational level might lead to geographic differences in the size of the mortality gap between men and women. This provides the opportunity to use information on geographical units at one, or several, points in time to empirically test hypotheses on the effect of the changing roles of men and women on sex differences in mortality. One can conjecture that regional differences at one point in time could give information on the possible causes of the changing mortality gap provided one adopts a framework of lagging and leading regions associated with changes in women's lifestyles and behaviour. Examples of such studies include those by Kawachi *et al.* (1999) at the US states level, by Anson (2001) on Belgium municipalities, and the longitudinal study (1950-92) by Waldron (2000) at the US national level.

Using indicators of women's economic and political autonomy as well as their reproductive rights at the US State level, Kawachi *et al.* (1999) tested the relationship between the status of women in society and women's health. Women's status was indicated using composite measures in the domain of political participation, employment and earnings, economic autonomy and reproductive rights. State-specific, age-standardised mortality rates by cause-of-death were the main dependent variables. Ordinary least squares (OLS) regression showed that high political participation by women was associated with lower overall mortality in both women and men, and with low female mortality from ischaemic heart disease (IHD) and cervical cancer. High scores on the employment and earnings index were only related negatively to male mortality and to female mortality due to cerebrovascular disease and cervical cancer. A high economic autonomy was associated with both low male and female mortality, but the reproductive rights index could not be associated with the mortality measures. The strengths of the associations found were even greater when the *differences* in male/female mortality rates were examined between states: where women's status was low, women's mortality rates were higher, and male mortality rates tended to be higher still. The association between women's status and male mortality was partly due to the fact that factors which adversely affect women's economic security also affect the material wellbeing of male members, such as spouses, partners, sons and fathers, of households to which these women belong.

Anson (2001) studied local area variations in male and female mortality in Belgium. He tried to identify the circumstances under which male, relative to female, mortality was particularly low or high by analysing age-specific standardised mortality ratios for Belgian communes during the period 1991-96 (with the total population as the standard). Four groups of factors (national origin, family structure, social status and cohabitation) were assumed to have structured male/female mortality differences. It was found that male mortality was more sensitive than female mortality to these factors, and regional differences between male and female mortality reflected these differences and the greater sensitivity of male mortality to these conditions. Male mortality disadvantages were lower in urban than in rural areas, and lower in areas of traditional living patterns, characterised by a stronger family focus (proportion married) and less cohabitation. The male disadvantage was greater the higher the women's relative social status, as measured by factors such as completed secondary or higher education. An important implication of these findings was, according to Anson, that as standards of living increase and the population becomes more urbanised, male and female mortality levels will draw closer together. At the same time, as household living arrangements are becoming less traditional, a contrary effect will take place.

The results of testing Waldron's hypotheses showed that, despite large changes in IHD among both men and women, the proportionate changes in the US were similar, so that sex mortality ratios were relatively stable. This result was in accord with the hypothesis that many of the factors which influence mortality trends have similar effects on males and females, such as the improvements that have been made in medical care. In contrast, for the other causes of death analysed, the trends in important causal factors have influenced one sex more than the other. Hence, males and females have experienced different mortality trends and sex mortality ratios have changed during at least part of the period studied. For instance, the initial increases and subsequent decreases in gender differences in smoking contributed to first increases and then decreases in sex differences associated with lung cancer and respiratory system diseases (Smoking Hypothesis). Conversely, little evidence was found to support the hypothesis that increasing women's employment increases female mortality and decreases gender differences in health-related behaviour and mortality (Women's Labour Force Participation Hypothesis). The predicted decreases in gender differences in health-related behaviour due to changing gender roles and the concomitant liberalisation of norms concerning women's behaviour (Women's Emancipation Hypothesis) were found in some instances (smoking and lung cancer, driving and motor vehicle accidents, and blue-collar employment and workplace accidents), although not in others (exercise, dietary fat intake, heavy drinking and the propensity to drink and drive). As heavy drinking is likely to be seen as being incompatible with traditional female responsibilities for childcare and sexual restraint, the fact that gender differences in heavy drinking remain large suggests that fundamental aspects of traditional gender roles continue to influence gender differences in health-related behaviour (Gender Roles Modernisation Hypothesis). However, the decreasing gender differences in cigarette smoking appear to have been due in part to increasing female use of smoking to aid weight control, which is compatible with the traditional female emphasis on appearance and is not perceived as being incompatible with women's responsibility for family care. Although the female gender role places greater emphasis on preserving health, in the case of smoking males have been more responsive to health campaigns.

7.3 Objectives

In this chapter recent changes in the male/female mortality gap in the Netherlands are investigated since, over the past two decades, there have been marked regional differences in the gender gap in mortality, as well as clear regional differences in the economic, behavioural and family situation of men and women, some of which have changed considerably over time.

In the early 1980s, female participation in the labour force was highest in the region known as the Randstad.[38] Although for males the geographic pattern was less distinct, except that levels tended to be low in the north, the resulting sex differences were lowest in the west and south of the country. Fifteen years later, levels of working women had increased dramatically in all regions, but only slightly more men were working. The exception was in the south, with the result that the decline in the gender difference in labour force participation was the least (*Figure 7.2a*). Overall, unemployment had increased slightly between the two periods. During the latter period there were, as a percentage of the total workforce, more women than men unemployed, particularly outside the Randstad. In 1980-83, unemployment levels were highest in the northern and southern regions and, in 1996-99, in the north and the three largest metropolitan regions, Groot-Rijnmond (which includes Rotterdam), Greater Amsterdam (Groot-Amsterdam) and The Hague ('s-Gravenhage). The geographic pattern differed little between the sexes.

The most important behavioural factor that affects mortality, i.e. smoking, was about twice as prevalent among men as women in 1972, but the difference was considerably less eight years later, as rates increased only slightly for men but by 50% on average among women. In geographic terms, male levels increased somewhat in the northern and south-eastern regions between 1972 and 1980 and remained relatively stable elsewhere while, among women, rates had increased everywhere, albeit least in the west. Overall, the geographical pattern had changed little: gender differences in smoking were still smallest in the west and greatest in a zone stretching from the south-west to the north-east of the country (*Figure 7.3*).

The family positions of men and women also varied strongly. The proportion of divorcees increased between the two periods, especially among women and in the Randstad region[39], where the highest levels were recorded during both periods (*Figure 7.2b*). The total fertility rate (TFR) was more or less the same in the two periods. At the regional level, the highest levels were found in the northern

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[38] This is the name given to a large, almost contiguous, horseshoe-shaped area with a polynuclear structure in the west of the Netherlands. It comprises the agglomeration of the four largest cities (Amsterdam, Rotterdam, The Hague and Utrecht), as well as a number of smaller cities. The 1999 population was about 6 million within an area of approximately 4500 km^2. See *Figure 7.1* for a map of the regions.

[39] Although all marriages and divorces in the Netherlands involved one member of each sex until 2001, in the period 1996-99 there were, on average, 6117 more married men than women but an excess of 108587 divorced women in the statistics. The former is probably the result of administrative errors and marriages to foreign nationals, while the second is partly due to the greater likelihood of remarriage among men. This pattern is accentuated among the 45-74 year olds studied here, as divorce rates are higher among this cohort than the average for the total population.

and eastern provinces of Friesland, Drenthe, Overijssel and Gelderland (the so-called bible belt), and the lowest levels in the west and south. Between the two periods, levels did converge slightly as the TFR increased in regions around Amsterdam and declined in the bible-belt regions (*Figure 7.2c*).

The current study is split into three parts. Firstly, the regional differences in life expectancy by sex at the beginning and end of the period under consideration, and the age groups and causes of death which were responsible for these differences are described. Following this, cross-sectional tests are used to see, for the two periods, whether differences in gender inequality have an effect on regional sex differences in mortality. Lastly, an attempt is made to identify factors that have played a role in reducing the mortality gap by studying the relationship between changes in gender inequality and changes in the male-female mortality gap over time. The two cross-sectional analyses coupled with the analysis over time allow one to ascertain the factors that contributed to regional differences in male-female mortality and to the changes in these differences over time.

Figure 7.1 Map of the regions used in the study

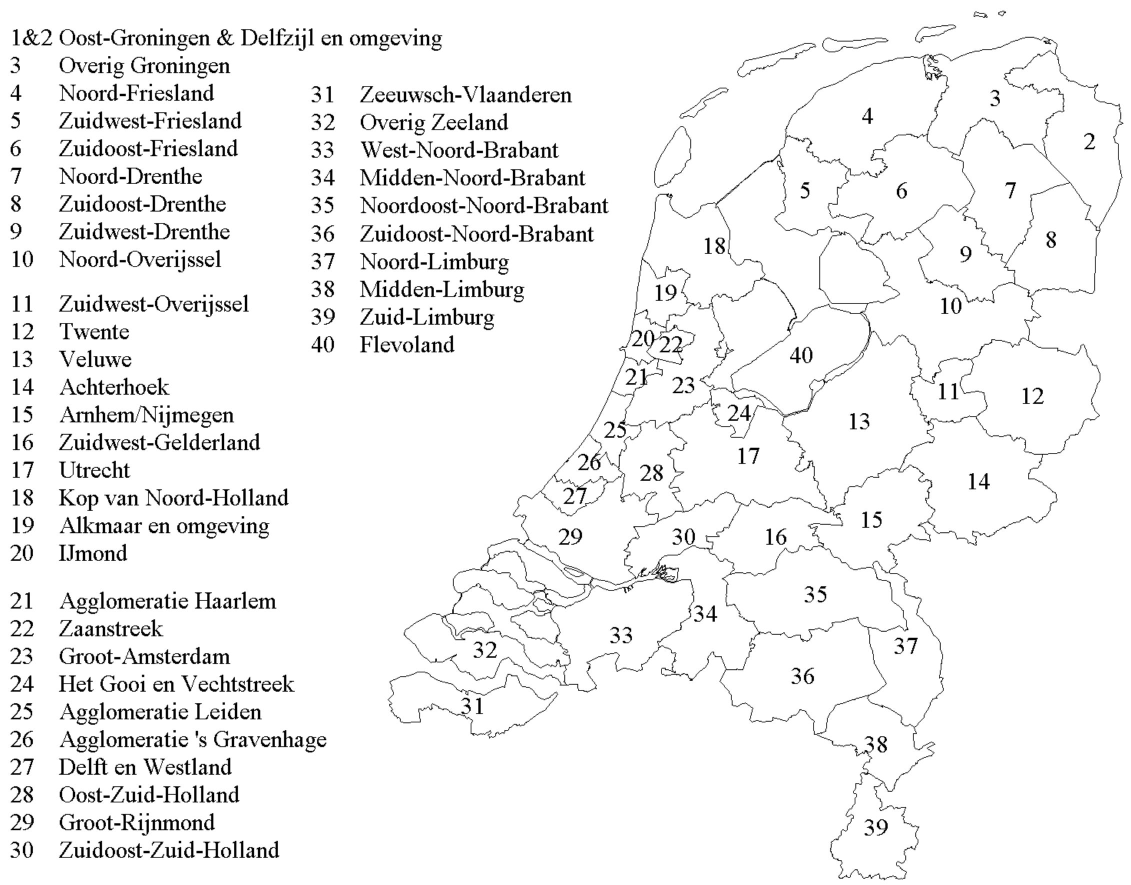


Figure 7.2 Percentage changes in gender differences in labour force participation (LFP) and divorce, and the change in the total fertility rate (TFR) between 1980-83 and 1996-99 in 38 Dutch regions.

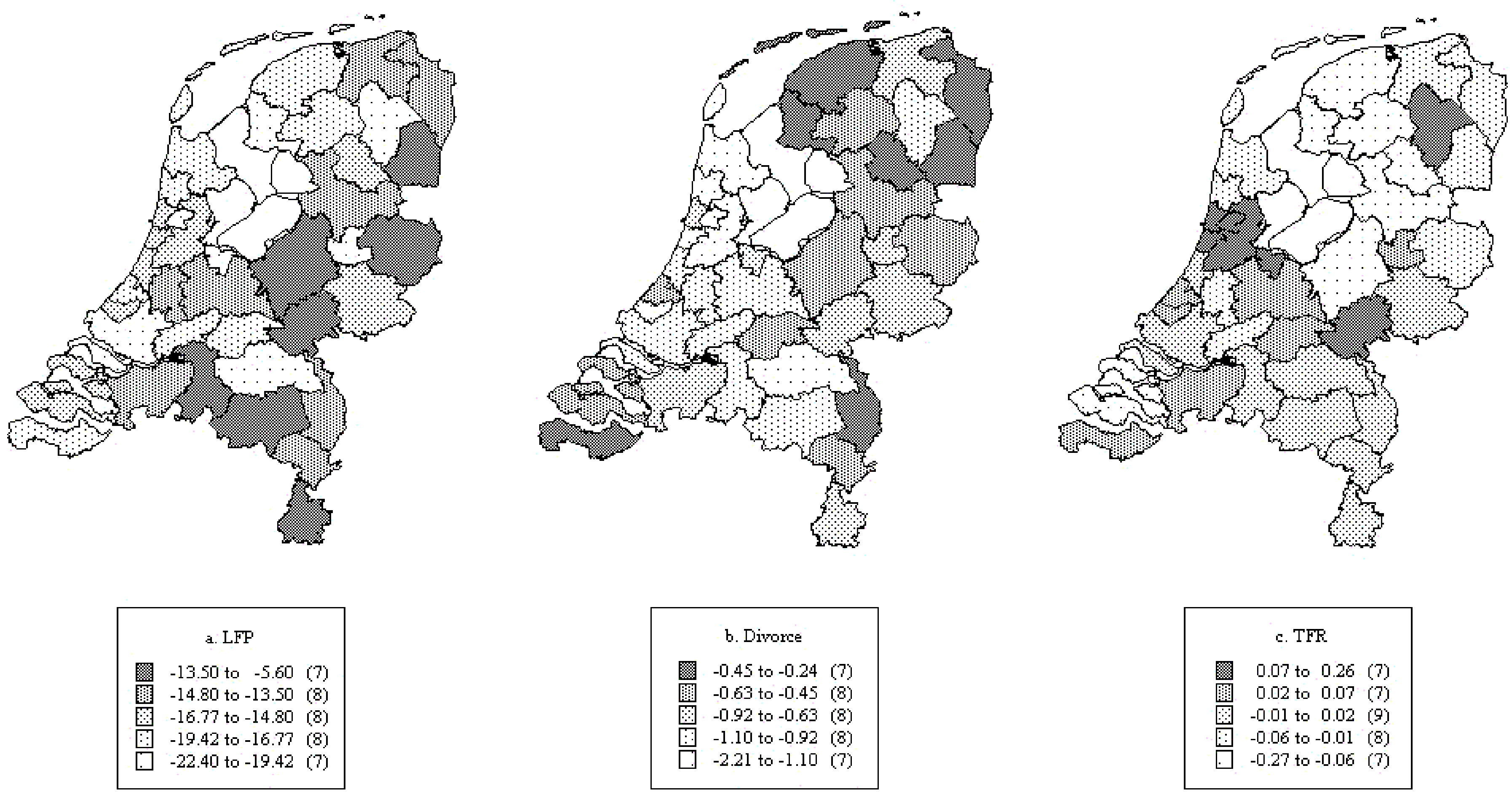
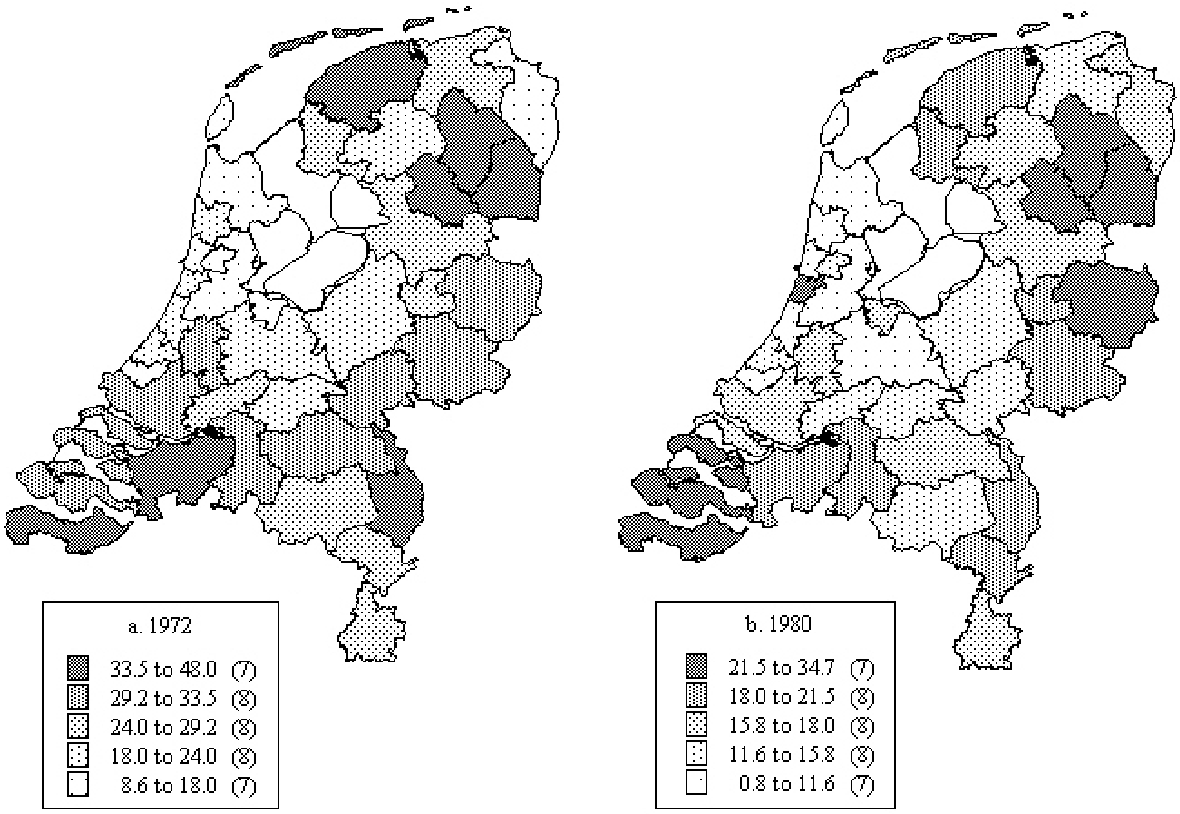


Figure 7.3 Male smoking prevalence excess in 1980-83 and 1996-99, showing the decline in the sex differences in 38 Dutch regions.



7.4 Material and Methods

The data used refers to 40 so-called 'COROP' regions in the Netherlands (Figure 7.1). These are statistical regions somewhat between the administrative levels of the province and the municipality. This subdivision, which was introduced in the early 1970s, is based on the relationship between one central, urban place and the surrounding area that is focused on this central location (or node). It was originally intended for regionalising statistics on the economy, based on criteria such as commuting and school attendance patterns (Vliegen, 1999). Only 38 regions were analysed: the Delfzijl region (due to its small population) was combined with the adjacent region Oost-Groningen, and the reclaimed area of Flevoland was excluded from the multivariate analyses because the majority of the population are first generation (predominantly healthy) internal and external migrants and are therefore likely to bias the results. The average population size of the regions was about 370,000 in the early 1980s and 400,000 in the late 1990s.

The numbers of deaths by age, sex, year of death, region of residence and cause of death were extracted from a large data file supplied by Statistics Netherlands (CBS). Causes of death were selected based on the level of sex differences in mortality (a male/female mortality ratio of 1.5 or more) and a minimum number of deaths (at least 1% of all deaths). This resulted in the selection of five of the most important cause-of-death groups plus eight specific diseases for the initial analysis. During the time period covered, deaths were classified according to two different International Classifications of Diseases (ICD-9 for the period 1980-83 and ICD-10 for the period 1996-99). Changes in the cause-of-death coding have been shown to have only minor effects on the trends in mortality. The selected causes of death and corresponding ICD codes are given in *Table 7.1*. In order to reduce random fluctuations in the regional figures, data were aggregated into two four-year periods: 1980-83, and 1996-99. The original data distinguished seven age groups: below 1, 1-24, 25-44, 45-64, 65-74, 75-84 and 85+. Details of the total population at risk by sex and age were obtained from unpublished CBS data. Between 1980 and 1982, these data apply to the 1st of January. For the remainder of the years it was possible to acquire data for both the first and last day of each year. This enabled the construction of a mid-year population for each COROP that was not affected by possible boundary changes in municipalities that take place on the 1st of January and, therefore, the regional mortality data should correspond to the population at risk. The mortality gap was calculated from the life expectancy difference between men and women, and to analyse the role played by specific age and cause-of-death groups, the number of years that each age and cause-of-death category contributed to the total sex difference in life expectancy was calculated. For this analysis the software package LIFETIME that was developed by Pollard (1989) was used[40].

Table 7.1 The causes of death selected for the study, their ICD codes, their percentage contribution to total mortality and the male to female mortality ratio (comparative mortality figure), period 1980-99

ICD-9 Code	ICD-10 Code	Name	% of total	M/F ratio
000-E999	**A00-Y89**	**All causes**	**100.00**	**1.72**
140-239	*C00-D48*	*Neoplasms*	*27.87*	*1.88*
161-162	C32-C34	Malignant neoplasm of trachea. bronchus and lung	6.73	7.36
174	C50	Malignant neoplasm of breast	5.32*	-
179-184	C51-C58	Malignant neoplasm of female genital organs	2.85*	-
185	C61	Malignant neoplasm of prostate	3.12*	-
390-459	**I00-I99**	**Diseases of the circulatory system**	**40.62**	**1.71**
410-414	I20-I25	Ischaemic heart disease	17.69	2.24
460-519	J00-J99	Diseases of the respiratory system	8.15	2.53
480-486	J12-J18	Pneumonia	3.10	1.52
490-496	**J40-J47**	**Chronic lower respiratory diseases**	**4.29**	**3.94**
780-799	**R00-R99**	**Symptoms. signs and ill-defined conditions**	**4.03**	**1.64**
E800-E999	**V01-Y89**	**External causes of injury and poisoning**	**4.30**	**1.86**
E800-E848	V01-V99	Transport accidents	1.16	2.83
E950-E959	X60-X84	Suicide and self-inflicted injury	1.22	1.92

** Essentially a sex-specific total*

40 LIFETIME requires the number of deaths in five-year age intervals, with the exception of the first two intervals (0 and 1-4 years) and the final age group (85+). As the COROP cause-specific mortality data that were obtained from the CBS had fewer age groups, the national data from the WHO Mortality Data Base (http://www.who.int/whosis/mort/download/htm#) that included all 19 age groups was used to redistribute the regional data. For a detailed overview of the method, see Spijker and Tabeau (1998).

The exogenous variables that are indicative of changes in the position of men and women were obtained from various sources and publications from CBS (*see Table 7.2*). Four types of indicators can be distinguished. Socioeconomic factors relate to the changing employment and educational status of men and women. Unfortunately, no reliable data could be obtained on sex-specific income levels. Family and household situation variables include information on fertility, divorce and living arrangements. Gender-specific information on behavioural factors reflects smoking, alcohol consumption and driving behaviour. Information on several contextual factors that might confound the regional differences in mortality was also collected. These contextual factors, which have been used in earlier comparable mortality studies, include relative material deprivation (see for example Kennedy *et al.*, 1996), housing quality (e.g. Townsend *et al.*, 1982; Phillimore *et al.*, 1994), urbanisation level (e.g. Mackenbach and Kunst, 1995; Schouten *et al.*, 1996; Mackenbach and Verkleij, 1997), norms and values, such as those ordained by religious beliefs, (e.g. Jarvis and Northcott, 1987) and ethnic composition (e.g. Van Wersch *et al.*, 1997. An index of relative material deprivation was constructed by aggregating standardised z-scores of three non-gender-specific variables that reflect distinctive aspects of material wellbeing: unemployment, housing tenure and the availability of central heating (c.f. Phillimore *et al.*, 1994).

Four of Waldron's hypotheses were tested, starting with her first and most straightforward conjecture that standardised mortality ratios have remained stable over time and, in the context of leading and lagging regions, also across space. The subsequent hypotheses tested were constructed to link mortality to several interrelated causal factors, but not all were direct translations of Waldron's hypotheses as this study opted for a more straightforward operationalisation of the hypotheses and avoided overlapping variables. Waldron's theoretical framework was therefore used as a means of determining several potential explanatory test-variables in the context of changing gender differences in behaviour.

The first hypothesis was the Smoking Hypothesis, which proposed that a decline in gender differences in cigarette smoking results in a decline in sex differences in mortality. The next hypothesis to be tested here is an approximation to Waldron's Labour Force Participation Hypothesis and proposes that a decline in gender differences in labour force participation results in a decline in gender differences in health-related behaviour and mortality. Gender differences in labour force participation and gender differences in unemployment were used in testing this hypothesis. The Gender Roles Modernisation Hypothesis was the last one to be tested, in which fertility levels and divorce were used as indicators of family gender roles. The assumption here is that lower levels of fertility and higher levels of divorce in space and/or time are indicative of less rigid gender roles, leading to fewer gender differences in behaviour, and subsequently, in mortality. As there seemed to be little distinction between Waldron's Women's Emancipation Hypothesis and the above, this hypothesis was not tested. Since traffic accident mortality has no causal link with smoking, it was decided to replace the Smoking Hypothesis with one derived from Trovato and Lalu (1996). Labelled the Reduction-in-Protection Hypothesis, this proposes that a decline in gender differences in road use results in a decline in sex differences in traffic accident mortality. This hypothesis, together with the other two, therefore tests if the argument that the integration of women into the world of work and social life outside the family weakens their protection and promotes the convergence over time of male and female deaths is also valid for road exposure.

Since, for many of these indicators, no time series data could be obtained or reconstructed, the analysis is restricted to a comparison of the periods 1980-83 and 1996-99. After some initial investigations, several variables were eliminated from further analysis, including education (see *Table 7.3* for reasons for exclusion)[41]. Summary statistics of the remaining variables, including the components of the deprivation index, are listed in *Table 7.4*. OLS regression was used to examine the statistical associations between the indicators of the changing social and economic position of men and women and the mortality indicator. Given the overall objective, most attention was given to age groups above 25. As the data were not linked with the mortality data, it was not possible to establish any *causal* factors that might have led to changes in the mortality differences between men and women (Jones and Moon, 1987; Greenland and Morgenstern, 1989).

During each hypothesis test, two context variables, deprivation and wages, were included as control variables, and the variables of the other hypotheses were also included even if they were insignificant. The hypothesis tests were performed on all cause, IHD, lung cancer and traffic accident mortality, as these are important contributors to the overall gap in male and female mortality. The age-specific contribution to the sex difference in life expectancy (in years of life) served as the dependent variable.

The analyses proceeded in a number of steps. Firstly, as reported in Section 7.5, a sex-specific analysis was performed of the regional determinants of regional differences in mortality, in order to establish the most important factors. Analyses of male-female mortality differences are discussed in the following sections. In the analysis of the *change* in the mortality difference, the average sex difference in mortality between the two periods was controlled for. This was to accommodate the possible bias in the regression towards the mean that could occur because regions with high levels of gender inequality in mortality in 1980-83 are statistically more likely to experience larger declines in gender differences in mortality than regions with already low levels of gender inequality.

[41] Overcrowded housing, urbanisation and gender differences in single parenthood and the proportion of ethnic minorities were excluded from the multivariate analysis due to their high correlations with at least one of the other variables. The proxies for religion, income inequality, gender differences in education, disability pension, alcohol consumption and widowhood were also excluded due to measurement bias, selection bias, or a lack of univariate correlation with each of the dependent variables.

Table 7.2 Variables used in the study, the period that the data covered and their definitions

	Abbrev.	1980-83	1996-99	Definition	Source	Notes
Socioeconomic factors						
Unemployment	dUNEMP	1980	1996-99	Gender difference in registered unemployment rates (labour force population aged 15-64)	1	1
Labour force participation	dLFP	1980-83	1989-90	Gender difference in percentage of the working age population (15-64) who are employed	2	2
Disability pension	dWAO	1981,83	1996-97	Gender diff in % of the population aged 15-64 entitled to receive a General Disablement Act pension	3	3
Education	dEDU	1981,83	1996-98	Gender difference in percentage of the population aged 15-64 with higher education	4	4
Sociodemographic factors						
Fertility	TFR	1980-83	1996-97	Total period fertility rate	5	5
Single parenthood	d1PARNT	1987	1997-99	Gender diff in % of persons living with >= 1children who are neither married or have own children	6	
Divorce	dDIVORCE	1980-83	1996-99	Gender difference in percentage of divorced persons (ages 45-74)	7	
Widowhood	dWIDOW	1980-83	1996-99	Gender difference in percentage of persons who are widowed (ages 45-74)	7	
Behavioural factors						
Smoking	dSMOK	1972	1980	Gender diff in % of adults persons who (occasionally) smoke (including hand-rolling tobacco)	8	
Alcohol consumption	dALC	1972	1980	Gender diff in % of persons who drink on average between 7-21glasses of alcoholic drinks per week	8	
Motor vehicles	CARS	1980,83	1996	Per capita number of vehicles	9	6
Driving licence	dLICENCE	-	1999-2000	Gender difference in percentage of adult population with a driving licence	10	
Travel distance	dDISTANCE	-	1999-2000	Gender difference in distance travelled by motor vehicle per day	10	
Contextual factors/confounders						
Wages	WAGES	1982	1996	Average yearly disposable income for those who receive an income during 52 weeks	11	7
Income inequality	GINI	1978	1994	GINI coefficient	12	8,9
Unemployment	UNEMPT	1980	1996-99	Total unemployment rates (labour force pop aged 15-64)	1	1
Rental housing	RENT	1981	1998	Percentage of houses that are being rented	13	
Overcrowded housing	ROOMS	1981	1998	Percentage of houses that have four or less rooms	13	
No central heating	NOCV	1981	1998	Percentage of houses without central heating	13	
Urbanisation	URB	1980-81,83	1996-99	Average number of inhabitants per km^2 of land	14	
Ethnic minorities	dETHNIC	1982	1995,2000	Gender difference in percentage of the population from an ethnic minority	15	10
Traditional gender roles	POLIT	1982	1998	Percentage of people who voted for Christian parties during the national elections	16	11

Sources

1 1980: CBS (1982a); 1996-99: CBS (2002a).
2 1981: Einerhand and Swaager (1985); 1996-99: CBS (2002a).
3 1981: CBS (1982a); 1983: CBS (1984a); 1996-97: CBS (2002b).
4 1981: Einerhand and Swaager (1985); 1983: CBS (1987); 1996-99: CBS (2002a).
5 Rijksplanologische Dienst (1999).
6 1987: CBS (1989); 1997-99: CBS (2002a).
7 CBS (2001a).
8 1972: Stichting Nationaal Onderzoek Persmedia (1972); 1980: CBS (1983).
9 1980: CBS (1982a); 1983: CBS (1984a); 1996: CBS (2002c).
10 CBS (2002d).
11 CBS (1984b); CBS (1998).
12 CBS (2002e).
13 1981: CBS (1984a); 1998: CBS (2002c).
14 1980-81: CBS (1981); 1983: CBS (1984a); 1996-96: CBS (2002c).
15 1982: CBS (1982b); 1995, 2000: CBS (2001b), Huisman and Van Wissen (1998).
16 1982:CBS (1986); CBS (2002f).

Notes

1 In a few instances where the number of unemployed was less than 2000, the original data did not include percentages. Nevertheless, using the totals and Province level data, including data on the number of people in the labour force, it was possible to estimate these.
2 This is equivalent to the gender difference in the total participation rate; employed persons include those who are insured in accordance with the Health Law, as well as civil servants; excluding those who work < 15 hours per week.
3 1996-97 includes public sector.
4 Higher education includes higher vocational education and tertiary education
5 TFR was calculated using five-year age-specific fertility rates and population figures.
6 Motor vehicles include passenger cars, company cars and motorcycles. Data after 1996 are not compatible with data from earlier years. This is because, from 1997 onwards, the number of vehicles includes both the active and the administrative motor vehicle fleets, which includes vehicles that are temporarily or permanently withdrawn from traffic.
7 Includes child support and housing rent subsidies
8 The GINI coefficient is derived from the Lorenz curve, which is a graphic device for representing the cumulative share of the total income accruing to successive income intervals. If all incomes were equal, the Lorenz curve would follow the 45º diagonal. As the degree of inequality increases so does the curvature of the Lorenz curve, and thus the area between the curve and the 45º line becomes larger. The GINI coefficient is calculated as the ratio of the area between the Lorenz curve and the 45º line divided by the whole area below the 45º line.
9 Data were published for municipalities only. These values were used to estimate the figures for the COROP regions, in which the number of persons who received an income was used as a weighting factor.
10 1982: ethnic minorities included non-nationals from all countries in the world except Belgium, Luxembourg, France, Italy, Federal Republic of Germany, United Kingdom, Ireland, Denmark and Greece (EC9). The average of the 1995 and 2000 ethnic minorities includes those persons with at least one foreign-born parent. Foreign, here, includes all non-western nations plus those countries from the former Soviet Union, the former Yugoslavia and Poland. As these latter figures were not sex-specific, it was necessary to apply sex-specific proportions. These were calculated from COROP data published in Huisman and Van Wissen (1998). While 'nationality' could reasonably be used for the first study period as very few non-EC9 foreigners had been naturalised before 1982; during the course of the 1980s many migrants from the labour-exporting countries began to take Dutch nationality, and many first generation migrants were having children. As a result, nationality was no longer a valid indicator of ethnicity by the second study period.
11 These political parties are the CDA, SGP, GPV and RPF.

Table 7.3 Variables excluded from the multivariate analysis

Variable	*Reason*
ROOMS	Highly correlated with RENT (ca 0.88); and dLFP in 1996-99 (-0.79)
d1PRNT	Highly correlated with RENT (ca. 0.86); dDIVORCE (ca 0.75); and dLFP in 1996-99 (0.76)
dETHNIC	Highly correlated with dLFP in 1996-99 (-0.80)
dALC	No data on high consumption levels could be obtained and low and moderate levels of alcohol consumption have little association with lung cancer and traffic accidents.
URB	Highly correlated with dDIVORCE (between 0.75 and 0.80)
dEDU and POLIT	No significant correlation with mortality from all causes, IHD and lung cancer ages 45-74 in either period
GINI	Opposite than expected association: the highest levels were often found in the wealthiest regions with low levels of deprivation and favourable mortality. The GINI coefficient may be more useful in testing the effects of extreme deprivation on health (Kennedy *et al.*, 1998).
dWAO	Selection bias: disability pension implies illness
dWIDOW	Selection bias: more female widows implies more male deaths

7.5 Regional differences in male and female mortality in 1980-83 and in 1996-99 and changes over time: a multivariate analysis

In this sex-specific analysis, the aim is to establish possible reasons for regional mortality differences among men and women. Two cross-sectional analyses were conducted, for the periods 1980-83 and 1996-99, as well as a dynamic analysis between the two periods. Regional differences or changes in life expectancy at birth was the dependent variable and was expressed in terms of all-cause or cause-specific contributions of age group 45-74 (for traffic accidents all ages). It should be noted that since this is a regression analysis of spatial units, spatial autocorrelation may cause a problem (Anselin, 1988). Spatial autocorrelation of the error terms in the regression equation will occur if omitted variables that affect mortality show a spatial pattern. In that event, the error terms are not independent, but correlated such that the correlation depends on the distance between the regions. Tests were conducted to see if the errors where spatially correlated for each cause of death and, fortunately, this turned out not to be the case[42] and therefore standard multiple regression techniques could be employed. As it is possible that different factors influence mortality patterns over space and time among men and women when sex differences are used as the dependent variable, for example because associations are not always in the same direction, separate analyses for men and women are first presented. This analysis does not enable the proposed hypotheses to be directly tested.

[42] This test was performed using a binary matrix of inter-regional linkages, in which the link in the matrix is 1 for neighbouring regions, and 0 for non-neighbouring ones.

Table 7.4 Summary statistics of variables used in the multivariate analysis: regional minimum and maximum values for men, women and the sex difference for the periods 1980-83, 1996-99 and the change between the two periods

		1980-83			1996-99			1996-99 – 1980-83		
		men	women	m-w	men	women	m-w	men	women	m-w
smoking prevalence (%)	Min	39.52	14.46	8.66	48.81	24.79	0.82	-7.99	1.08	-20.35
	Max	72.99	45.01	47.96	70.15	52.89	34.69	13.30	22.21	0.70
	Mean	54.02	27.55	26.47	57.30	40.21	17.09	3.28	12.66	-9.38
unemployment (%)	Min	1.49	1.78	-5.38	1.82	2.81	-3.70	-2.31	-3.79	-2.36
	Max	7.19	10.81	0.85	8.90	10.77	0.90	3.03	4.05	1.68
	Mean	3.75	5.12	-1.37	4.05	5.66	-1.61	0.30	0.54	-0.24
labour force participation (%)	Min	64.22	20.69	31.36	67.5	38.56	15.75	-3.33	14.77	-22.38
	Max	78.4	39.15	52.59	79.75	56.75	33.25	10.18	22.25	-5.60
	Mean	72.79	29.11	43.68	74.88	47.23	27.66	2.09	18.12	-16.03
divorce (% of total population)	Min	1.88	1.98	-1.99	5.46	6.38	-2.84	3.49	3.98	-2.20
	Max	7.03	8.36	0.27	14.70	17.45	-0.11	7.67	9.09	-0.24
	Mean	3.27	3.72	-0.45	8.03	9.30	-1.27	4.76	5.58	-0.82
TFR	Min		1.23			1.31			0.08	
	Max		1.97			1.86			-0.11	
	Mean		1.58			1.58			-0.01	
wages	Min		25800			37000			11200	
	Max		29850			45400			15550	
	Mean		27304			40303			12998	
deprivation index	Min		-2.73			-2.86			-0.13	
	Max		5.25			6.55			1.30	
	Mean		0			0.00			0.00	
% of rental housing	Min		39			34.04			-4.96	
	Max		82			72.45			-9.55	
	Mean		54.16			45.75			-8.41	
% without central heating	Min		12			3.25			-8.75	
	Max		53			28.58			-24.42	
	Mean		33.03			12.33			-20.70	
total unemploy-ment rate	Min		1.81			2.35			0.54	
	Max		8.25			9.20			0.95	
	Mean		4.13			4.63			0.50	
motor vehicles per 100 persons	Min		32.66			34.68			2.02	
	Max		39.62			46.33			6.71	
	Mean		35.93			39.25			3.32	
driving licence (% of adult pop)	Min				77.20	60.00	11.58			
	Max				91.90	80.30	23.81			
	Mean				87.67	70.68	16.99			
distance travel -led (km/day)	Min				30.04	20.42	8.63			
	Max				44.64	30.44	15.94			
	Mean				38.48	26.43	12.06			

Note: The two periods refer to the mortality data. For the respective time periods of the exogenous data, see Table 7.2.

Total mortality

The 1980-83 all-cause models for men and women were very similar. Regions with high levels of unemployment and divorce tended to observe below average life expectancy (*Tables 7.5* and *7.6*). Regional smoking differences were too small to be associated with differences in mortality after controlling for other variables (see *Table 7.7* for the univariate correlations with the mortality indicators). Why the relative deprivation indicator was positively associated with lower mortality is uncertain but it may be that, at this level of aggregation, deprivation is not severe enough to affect mortality. This discrepancy remained after controlling for other variables. Although the coefficient of unemployment was essentially the same in the 1996-99 model for total mortality among males, it was no longer significant. Now, labour force participation was more important, exhibiting a detrimental effect on health. TFR 'replaced' divorce and showed, like wages, the expected positive effect on health. Among women, none of the variables could be associated with regional differences in total mortality among the 45-74 year olds in the second period. Between the two periods, regions with the largest declines in smoking and greatest increases in female fertility levels, income and relative deprivation saw their relative positions in terms of male mortality improve the most. For women, only unemployment showed a significant, and detrimental, effect.

Lung cancer

None of the variables pertaining to the hypotheses, including smoking, explained male lung cancer mortality differences in the early 1980s, but both smoking and divorce demonstrated independent and negative effects on women. For the latter period, regional differences in unemployment levels were associated with male mortality, and again smoking with female mortality. Although divorce appeared to be a protection against male lung cancer, this may be explained by the fact that in the highly urbanised Randstad region, which is regarded as the cultural centre of the nation (Mackenbach and Kunst, 1995), not only was divorce more common but people also responded more quickly to health campaigns. This may have led to an earlier decline in lung cancer than in other regions. Since, at the individual level, lung cancer mortality is likely to be higher among the divorced than among the married, as was found by Joung (1996) at the national level in the late 1980s, we are faced with the problem of ecological fallacy. Between the two periods, labour force participation was not related to female mortality but it did have a protective influence on male mortality.

Ischaemic heart disease

Turning to IHD, results for the early 1980s showed that unemployment explained some of the regional differences among both men and women. Among men, the other variables were not significant, but among women the average number of children born had a protective effect as did the level of material deprivation. Both of the gender role modernisation variables explained some of the differences in male IHD mortality in the late 1990s, but again there were no significant variables in the model for women. Between the two periods, changes in smoking habits explained the regional changes in male mortality, while unemployment was the most significant variable for women.

Table 7.5 Association between all-cause and cause-specific mortality in 1980-83, 1996-99 and over the two periods, and various types of determinants: outcome of regression analysis, men

	ages 45-74 Total	ages 45-74 Lung	ages 45-74 IHD	all ages Traffic 1	all ages Traffic 2
		1980-83			
(Constant)	-1.06	-0.19	-0.61	-0.86	
SMOK (x 1000)	-6.39	-1.33	4.00		
CARS (x 100)				-9.54	
LFP (x 100)	1.97	0.95	0.35	-0.59	
UNEMP (x 100)	-13.14 **	-2.16	-8.10 **	-1.46	
TFR	0.05	0.03	0.16	-0.14	
DIVORCE (x 100)	-17.59 **	-3.53	2.91	4.05	
WAGES (x 100000)	5.82	-0.63	1.55	6.62 *	
DEPRIV (x 100)	10.60 ***	3.86 ***	1.96	1.05	
% variance explained	55	23	42	56	
		1996-99			
(Constant)	0.77	0.67	0.07	-0.30	-0.30
SMOK (x 1000)	-15.47	-1.98	-1.91		
CARS (x 100)				-1.35 **	-1.33 **
LICENCE (x 100)					-0.03
DISTANCE (x 100)					-0.16
LFP (x 100)	-8.21 *	-1.52	-1.13	-0.54	-0.55
UNEMP (x 100)	-12.99	-6.61 ***	-8.63 **	0.83	0.94
TFR	1.71 **	0.18	0.43 *	-0.06	-0.04
DIVORCE (x 100)	3.13	2.73 **	4.49 **	2.23	2.12
WAGES (x 100000)	9.76 **	0.85	0.49	2.83 **	2.93 **
DEPRIV (x 100)	-1.27	2.05	0.94	-0.29	-0.31
% variance explained	45	45	44	50	46
			1996-99 - 1980-83		
(Constant)	-1.76 **	-0.86 ***	-0.39	0.34	
ave 80-83 & 96-99	0.03	-0.18	-0.63 ***	-0.28	
SMOK (x 1000)	-24.03 **	-6.16 *	-10.86 *		
CARS (x 100)				0.74	
LFP (x 100)	0.98	1.39 *	-0.48	0.53	
UNEMP (x 100)	-5.40	-0.71	-1.52	0.73	
TFR	-1.10 *	-0.22	-0.48	0.06	
DIVORCE (x 100)	3.42	4.54 *	-0.14	-0.97	
WAGES (x 100000)	11.27 **	4.52 ***	3.07	-2.10	
DEPRIV (x 100)	8.34 *	2.46	1.30	0.47	
% variance explained	19	32	34	-5	

*Note: From multiple regression analysis of regional differences in male mortality, expressed in years of life expectancy for the three types of determinants: smoking (or traffic variables in the case of traffic accidents), labour force participation variables and gender roles modernisation variables. N = 38 regions, * P < 0.10; ** P < 0.05; *** P < 0.01.*

Table 7.6 Association between all-cause and cause-specific mortality in 1980-83, 1996-99 and over the two periods, and various types of determinants: outcome of regression analysis, women

	ages 45-74 Total	ages 45-74 Lung	Ages 45-74 IHD	all ages Traffic 1	all ages Traffic 2
		1980-83			
(Constant)	0.10	0.31	-0.22	-0.25	
SMOK (x 1000)	-0.28	-1.18 **	-1.11		
CARS (x 100)				0.10	
LFP (x 100)	0.09	-0.07	1.02	-0.61 *	
UNEMP (x 100)	-13.89 ***	-0.49	-5.04 ***	-1.17	
TFR	0.20	0.03	0.24 **	-0.04	
DIVORCE (x 100)	-12.42 ***	-0.95 *	-0.36	1.31	
WAGES (x 100000)	4.35	-0.77	-0.10	1.79	
DEPRIV (x 100)	11.43 ***	-0.20	3.12 ***	0.64	
% variance explained	53	57	65	31	
		1996-99			
(Constant)	-1.52	0.08	0.05	-0.42	-0.53
SMOK (x 1000)	-11.23	-2.68 *	-2.49		
CARS (x 100)				0.10	-0.09
LICENCE (x 100)					0.31
DISTANCE (x 100)					0.10
LFP (x 100)	-0.63	0.21	-0.49	-0.07	-0.18
UNEMP (x 100)	-0.67	0.25	-1.94	-0.52	-0.63
TFR	0.12	0.13	-0.04	-0.01	-0.01
DIVORCE (x 100)	-1.58	-0.85	1.00	0.18	0.77
WAGES (x 100000)	5.84	-0.45	0.89	1.12 *	0.99
DEPRIV (x 100)	-1.70	-0.90	-0.28	0.93	0.99 *
% variance explained	19	42	39	18	17
			1996-99 - 1980-83		
(Constant)	-0.22	-0.09	0.00	-0.06	
ave 80-83 & 96-99	0.33	1.09 ***	-0.59 ***	-0.03	
SMOK (x 1000)	8.13	-2.08	0.16		
CARS (x 100)				0.92 *	
LFP (x 100)	-0.76	-0.03	-0.78	0.44	
UNEMP (x 100)	-12.80 ***	-0.75	-3.41 ***	0.32	
TFR	-0.55	-0.04	-0.05	0.01	
DIVORCE (x 100)	7.31	2.10 **	0.61	0.78	
WAGES (x 100000)	-0.62	-0.02	1.00	-0.71	
DEPRIV (x 100)	7.47	-0.58	1.72	-1.12	
% variance explained	21	53	50	9	

*Note: From multiple regression analysis of regional differences in female mortality, expressed in years of life expectancy for the three types of determinants: smoking (or traffic variables in the case of traffic accidents), labour force participation variables and gender roles modernisation variables. N = 38 regions, * P < 0.10; ** P < 0.05; *** P < 0.01.*

Table 7.7. Univariate association between all-cause and cause-specific mortality and various types of determinants for 1980-83, 1996-99 and the difference between the two periods

	ages 45-74 Total			ages 45-74 lung			ages 45-74 IHD			all ages traffic		
	80-83	96-99	change	80-83	96-99	change	80-83	96-99	change	80-83	96-99	change
Men												
SMOK	**-0.31**	**-0.35**	**-0.32**	**-0.23**	**-0.43**	**-0.22**	-0.13	**-0.36**	-0.07			
CARS										0.09	**-0.44**	0.15
LICENCE											**-0.57**	
DISTANCE											-0.20	
LFP	**0.60**	**0.46**	0.07	**0.35**	0.17	**0.29**	**0.49**	**0.48**	0.07	0.03	-0.10	0.06
UNEMP	**-0.61**	**-0.52**	-0.08	-0.18	-0.19	0.03	**-0.70**	**-0.48**	**-0.29**	**-0.46**	0.16	-0.17
TFR	**0.32**	**0.42**	-0.15	**0.30**	0.06	**0.25**	-0.03	**0.25**	**-0.33**	**-0.56**	**-0.40**	**-0.21**
DIVORCE	-0.13	-0.11	-0.07	-0.03	**0.41**	**0.28**	**0.29**	0.15	**-0.27**	**0.66**	**0.60**	-0.21
WAGES	**0.46**	**0.53**	**0.29**	0.03	**0.41**	**0.42**	**0.56**	**0.51**	**-0.26**	**0.52**	**0.36**	**-0.31**
DEPRIV	-0.20	**-0.37**	0.05	0.21	0.05	0.08	-0.18	**-0.28**	0.05	0.09	0.18	0.00
Women												
SMOK	-0.02	**-0.22**	**0.26**	**-0.52**	**-0.37**	0.09	0.21	-0.07	**0.46**			
CARS										0.13	-0.05	**0.34**
LICENCE											-0.08	
DISTANCE											0.12	
LFP	0.05	0.04	0.02	**-0.61**	**-0.33**	**0.24**	**0.49**	**0.44**	-0.07	**0.36**	**0.39**	**0.29**
UNEMP	**-0.52**	**-0.41**	**-0.47**	0.11	-0.12	**-0.25**	**-0.70**	**-0.63**	**-0.59**	**-0.47**	**-0.29**	**-0.21**
TFR	**0.35**	**0.28**	-0.09	**0.62**	**0.54**	-0.19	0.10	0.01	-0.02	**-0.24**	-0.16	0.01
DIVORCE	-0.06	**-0.25**	-0.13	**-0.72**	**-0.63**	**-0.26**	**0.42**	**0.22**	**-0.24**	**0.45**	**0.38**	-0.10
WAGES	**0.36**	**0.40**	0.16	-0.19	-0.05	0.08	**0.48**	**0.64**	-0.03	**0.48**	**0.42**	-0.12
DEPRIV	-0.07	**-0.45**	-0.02	**-0.35**	**-0.41**	-0.15	0.01	**-0.37**	-0.10	0.04	0.07	**-0.34**

*Note: Significant associations are printed **in** **bold** (p<0.10; 1-sided)*

Traffic accidents

In the 1980-83 model for male traffic accident mortality, the average wage level was positively associated with lower mortality, perhaps because of its association with safer cars. Among women, the only association found was with labour force participation and this increased the risk of dying from motor vehicle accidents. By 1996-99, this was no longer the case: average wages were now significant and protective. This variable was again significant in the male model, and was joined by the number of vehicles per capita which was positively associated with fatal motor vehicle accidents. This position did not change after including the other two variables, holding a driving licence and distance travelled, in the model. These two variables were themselves insignificant and the coefficients of the other variables hardly changed when they were included. Over time, none of the factors could explain the changes in male traffic accident mortality, and for women only the increase in the number of cars had an influence, although the association was in the wrong direction. Unfortunately, no information could be obtained on the improvements that have been made in terms of car safety that might have out-weighed the disadvantages of there being more cars on the road.

To sum up, although the univariate associations did not differ much between the sexes, this was no longer the case when all the explanatory variables were included in the models. The main change in the 1980-83 models were that, for both lung cancer and IHD, gender role modernisation played a role in regional mortality differences. With the 1996-99 results, the variables in the female models were of little importance, whereas at least one of the labour force participation and gender role modernisation variables was present in the all-cause, lung cancer and IHD models for men. Both of the cross-sectional results showed that regional differences in smoking were sufficient to explain some of the regional differences in lung cancer mortality among women, but not among men. Conversely, due to the large decline in male smoking prevalence rates, it could explain part of the regional differences in the decline in total and cause-specific mortality, but this is yet to become apparent for women. The analysis over time indicated the protective effect of labour force participation for men in terms of lung cancer and the detrimental effect of unemployment among women in all-cause and IHD mortality.

7.6 Regional differences and changes over time in the male/female mortality gap and sex ratio

Life expectation increased for both sexes, and the male/female mortality gap declined, in the Netherlands between the periods 1980-83 and 1996-99. These two time periods represent, respectively, the peak of male excess mortality and the most recent period in which the male disadvantage has clearly declined. Among the regions, with the exception of Flevoland, sex differences in life expectancy varied between about 5.8 and 7.3 years in 1980-83, and 4.9 and 6.4 years in 1996-99. With a few exceptions, regions in the south of the country displayed the smallest differences in the earlier period, and regions in the north-west and west in the latter period, but there was no unequivocal geographical pattern to sex differences in life expectancy at birth (*Table 7.8*).

Between the early 1980s and the late 1990s, male and female life expectancy increased in all regions, with one exception: the effect of healthy migration attenuated in Flevoland resulting in a drop in female life expectancy. The largest increases in female life expectancy were in the southern part of the country and north and west of Groot-Amsterdam and the Zaanstreek (*Figure 7.4a*). The pattern was similar for men, although not all southern regions experienced an above average increase in life expectancy (*Figure 7.4b*). Except in Zeeuws-Vlaanderen, the increase in life expectancy at birth between the two periods was greater for men than for women (*Figure 7.4c*) Over the entire country, men closed the gap on women in terms of life expectancy at birth by 1.2 years. In the central and western parts of the country the decline in the gap ranged between 1.4 and 2 years, whereas in all southern regions it was below average.

At the national level, the 45-64 and 65-74 age groups were mainly responsible for the sex difference in life expectancy in the first period, each age group contributing just over two years (61% of the total difference; see *Table 7.9*). In the 1996-99 period, this age pattern had shifted, with the highest contributions found among the 65-74 and 75-84 age groups. The contributions were 1.7 and 1.5 years, respectively, contributing 57% of the total sex difference in life expectancy at birth.

In terms of causes of death, diseases of the circulatory system made the largest contribution to male excess mortality in the period 1980-83 (2.9 years or 43%), and in particular IHD (2.1 years).[43] Cancer followed with 1.8 years (27% of total), with lung cancer being the largest contributor within this cause-of-death category (1.5 years). However, the two cancers that only effect women, i.e. breast cancer[44] and cancer of the female genital organs, reduced the male excess mortality by no less than 0.9 years. Prostate cancer was responsible for 0.3 years of the male excess mortality. The third most important cause-of-death group was external causes. Just over half of the 0.6 years (or 9%) that this group contributed to the higher life expectancy of women was attributable to traffic accidents. Diseases of the respiratory system were responsible for a similar proportion of the total life expectancy difference as external causes.

As the total sex difference in mortality declined between the two periods, it is not surprising that the absolute contributions of the main causes of death to the sex difference in life expectancy in 1996-99 were also less. The rank order of the causes of death remained similar: circulatory system diseases contributed 2.1 years (or 38%), cancer 1.5 years (27%), followed by diseases of the respiratory system (0.7 years or 12%) and external causes (0.5 years or 9%).

There were also spatial variations in the contributions that each cause of death made to the sex difference in mortality. In terms of IHD, in both periods, the largest sex differences were found in

[43] Cause-of-death results relate to the total for all ages.

[44] The number of male deaths from breast cancer is very small (about 30 per year).

several of the northern regions and the smalllest in the west and south-west of the country. A similar pattern was found with traffic accidents. Sex mortality differences from both lung cancer and respiratory system diseases were highest in the south-west (excluding Zuid-Limburg in the case of cancer) and lowest in the north (1980-83) or the west (1996-99) of the country.
The differences between male and female mortality over the two periods declined in all but the eldest two age-categories. The largest contributor to the decline in male excess mortality occurred between the ages of 45 and 74 (about 1.2 years). In the 0-45 age group, mortality differences declined by a quarter of a year, while concurrently, the sex-gap *increased* by the same amount for those above the age of 75. In terms of causes of death, the largest contributors to closing the gap were IHD (0.9 years) and lung cancer (0.5 years), while traffic accidents made a small contribution (0.1 years). The aggregate of these three specific causes of death was greater than the total reduction of 1.2 years because developments in the incidence of cancer of the female genital organs, other heart diseases, prostate cancer, chronic lower respiratory diseases and suicide all slightly increased the female advantage.

As only the developments in IHD, lung cancer and traffic accident mortality caused a decline in the mortality differences between males and females, the further analyses were limited to these three causes of death. The aetiology of these diseases indicates that behavioural factors are likely to play an important role in this changing pattern.
When the *decline* in the female life expectancy advantage between the two periods is broken down into the contributions from lung cancer, IHD and traffic accidents, the spatial patterns that arise differ from the pattern observed for total mortality. A decline in the male-female difference in life expectancy due to lower male lung cancer mortality was particularly evident in the western regions. Here, contributions were all greater than 0.5 years, whereas male lung cancer mortality compared to that of females only marginally improved in the north of the country (*Figure 7.5a*). With respect to IHD (*Figure 7.5b*), the pattern was somewhat different, with most of the northern regions recording the highest declines. Even so, the regions with the smallest declines still showed at least a half-year reduction in the female mortality advantage, thus emphasising the importance of this cause of death in the general decline in sex differences in mortality. Turning to traffic accidents, the results are less clear cut. *Figure 7.5c* indicates that both the north and the west had regions that recorded virtually no decline in sex differences in mortality from this cause alongside regions that had declines greater than 0.1 years.

Table 7.8 Expectation of life at birth by sex and region, 1980-83 and 1996-99 and the decline in female advantage

	Period 1980-83			Period 1996-99			Decline in female advantage
Name of region	Females	Males	Diff	Females	Males	Diff	
Oost-Groningen, Delfzijl en omgeving	79.25	72.32	6.93	79.64	73.85	5.79	1.14
Overig Groningen	79.76	72.83	6.93	80.25	74.90	5.35	1.58
Noord-Friesland	80.00	72.67	7.33	80.78	74.77	6.01	1.32
Zuidwest-Friesland	79.56	73.09	6.47	80.59	75.58	5.01	1.46
Zuidoost-Friesland	80.03	73.30	6.73	80.96	75.25	5.71	1.02
Noord-Drenthe	79.73	73.38	6.35	80.93	75.54	5.39	0.96
Zuidoost-Drenthe	79.03	72.63	6.40	80.73	74.36	6.37	0.03
Zuidwest-Drenthe	80.09	73.94	6.15	81.18	75.72	5.46	0.69
Noord-Overijssel	79.73	73.04	6.69	80.94	75.18	5.76	0.93
Zuidwest-Overijssel	80.10	73.27	6.83	80.52	75.13	5.39	1.44
Twente	78.81	72.27	6.54	79.95	74.44	5.51	1.03
Veluwe	79.66	72.85	6.81	80.61	75.25	5.36	1.45
Achterhoek	79.65	72.68	6.97	80.71	75.10	5.61	1.36
Arnhem/Nijmegen	79.24	72.06	7.18	80.16	74.69	5.47	1.71
Zuidwest-Gelderland	79.40	72.73	6.67	80.09	74.81	5.28	1.39
Utrecht	79.70	72.95	6.75	80.61	75.21	5.40	1.35
Kop van Noord-Holland	79.08	72.56	6.52	80.74	75.58	5.16	1.36
Alkmaar en omgeving	79.47	72.49	6.98	81.37	76.25	5.12	1.86
IJmond	79.86	72.86	7.00	81.33	75.33	6.00	1.00
Agglomeratie Haarlem	79.21	72.39	6.82	81.09	74.91	6.18	0.64
Zaanstreek	79.91	73.52	6.39	80.52	74.98	5.54	0.85
Amsterdam	78.82	72.13	6.69	79.94	74.70	5.24	1.45
Het Gooi en Vechtstreek	80.34	73.73	6.61	81.18	76.27	4.91	1.70
Agglomeratie Leiden en Bollenstreek	80.09	72.90	7.19	80.92	75.74	5.18	2.01
Agglomeratie 's Gravenhage	79.42	72.55	6.87	80.40	74.96	5.44	1.43
Delft en Westland	80.86	74.02	6.84	81.96	76.49	5.47	1.37
Oost-Zuid-Holland	80.26	73.67	6.59	81.23	76.10	5.13	1.46
Rijnmond	79.49	72.70	6.79	80.45	74.85	5.60	1.19
Zuidoost-Zuid-Holland	79.38	72.98	6.40	80.84	75.42	5.42	0.98
Zeeuwsch-Vlaanderen	79.09	73.29	5.80	82.06	76.20	5.86	-0.06
Overig Zeeland	80.29	74.22	6.07	81.61	76.27	5.34	0.73
West-Noord-Brabant	78.69	72.82	5.87	80.56	75.16	5.40	0.47
Midden-Noord-Brabant	78.59	72.15	6.44	80.24	74.42	5.82	0.62
Noordoost-Noord-Brabant	78.89	72.61	6.28	80.19	74.87	5.32	0.96
Zuidoost-Noord-Brabant	79.13	72.34	6.79	80.65	74.94	5.71	1.08
Noord-Limburg	78.45	71.91	6.54	80.05	74.58	5.47	1.07
Midden-Limburg	78.65	72.65	6.00	80.21	74.81	5.40	0.60
Zuid-Limburg	78.47	71.58	6.89	80.04	74.18	5.86	1.03
Flevoland	82.35	74.38	7.97	80.42	75.58	4.84	3.13
Netherlands	**79.41**	**72.70**	**6.71**	**80.54**	**75.05**	**5.49**	**1.22**

Table 7.9 Age- and cause-of-death contributions to sex differences in life expectancy at birth in the Netherlands, 1980-83, 1996-99 and differences between the two periods (in years - only results >± 0.05 are shown)

Cause of death	All ages	0	1-24	25-44	45-64	65-74	75-84	85+
1980-83								
All causes	**6.71**	**0.16**	**0.33**	**0.40**	**2.04**	**2.08**	**1.37**	**0.33**
Neoplasms	1.81			-0.05	0.44	0.77	0.51	0.11
Malignant neoplasm of trachea. bronchus & lung	1.48				0.54	0.57	0.30	0.05
Malignant neoplasm of breast	-0.58			-0.09	-0.30	-0.11	-0.06	
Malignant neoplasm of female genital organs	-0.31				-0.15	-0.08		
Malignant neoplasm of prostate	0.31					0.10	0.12	0.05
Diseases of the circulatory system	2.90			0.14	1.18	0.93	0.53	0.11
Ischaemic heart disease	2.11			0.12	0.95	0.64	0.33	0.07
Other heart diseases	0.38				0.13	0.11	0.09	
Cerebrovascular disease	0.23				0.06	0.10	0.07	
Diseases of the respiratory system	0.59				0.08	0.20	0.21	0.08
Pneumonia	0.08							
Chronic lower respiratory diseases	0.44				0.07	0.16	0.16	0.05
Diseases of the digestive system	0.15				0.06	0.05		
Symptoms. signs and ill-defined conditions	0.34			0.06	0.12	0.06		
External causes of injury and poisoning	0.63		0.25	0.21	0.11			
Transport accidents	0.33		0.16	0.09				
Suicide and self-inflicted injury	0.12			0.05				
Remainder of main causes	0.29	0.12						
1996-99								
All causes	**5.51**	**0.09**	**0.25**	**0.31**	**1.23**	**1.67**	**1.49**	**0.47**
Neoplasms	1.49			-0.07	0.21	0.63	0.53	0.17
Malignant neoplasm of trachea. bronchus & lung	0.97				0.26	0.38	0.27	0.06
Malignant neoplasm of breast	-0.60			-0.08	-0.31	-0.12	-0.07	
Malignant neoplasm of female genital organs	-0.26				-0.11	-0.07		
Malignant neoplasm of prostate	0.38					0.11	0.15	0.08
Diseases of the circulatory system	2.09			0.07	0.64	0.69	0.54	0.14
Ischaemic heart disease	1.21			0.05	0.41	0.39	0.28	0.08
Other heart diseases	0.45				0.14	0.13	0.11	
Cerebrovascular disease	0.18					0.08	0.06	
Diseases of the respiratory system	0.65					0.18	0.29	0.14
Pneumonia	0.15						0.07	
Chronic lower respiratory diseases	0.45					0.13	0.21	0.09
Diseases of the digestive system	0.13				0.05			
Symptoms. signs and ill-defined conditions	0.29				0.11	0.06		
External causes of injury and poisoning	0.52		0.17	0.21	0.09			
Transport accidents	0.21		0.09	0.07				
Suicide and self-inflicted injury	0.18			0.08				
Remainder of main causes	0.30	0.07			0.09	0.06		
Difference								
All causes	**1.20**	**0.07**	**0.08**	**0.09**	**0.81**	**0.41**	**-0.12**	**-0.14**
Neoplasms	0.32				0.23	0.14		-0.06
Malignant neoplasm of trachea. bronchus & lung	0.51				0.28	0.19		
Malignant neoplasm of breast								
Malignant neoplasm of female genital organs	-0.05							
Malignant neoplasm of prostate	-0.07							
Diseases of the circulatory system	0.81			0.07	0.54	0.24		
Ischaemic heart disease	0.90			0.07	0.54	0.25	0.05	
Other heart diseases	-0.07							
Cerebrovascular disease	0.05							
Diseases of the respiratory system	-0.06						-0.08	-0.06
Pneumonia	-0.07							
Chronic lower respiratory diseases					0.05		-0.05	
Diseases of the digestive system								
Symptoms. signs and ill-defined conditions	0.05							
External causes of injury and poisoning	0.11		0.08					
Transport accidents	0.12		0.07					
Suicide and self-inflicted injury	-0.06							
Remainder of main causes		0.05			-0.05			

Figure 7.4 Changes in life expectancy at birth between 1980-83 and 1996-99 in 39 Dutch regions: female and male improvements, and the decline in the female advantage (in years)

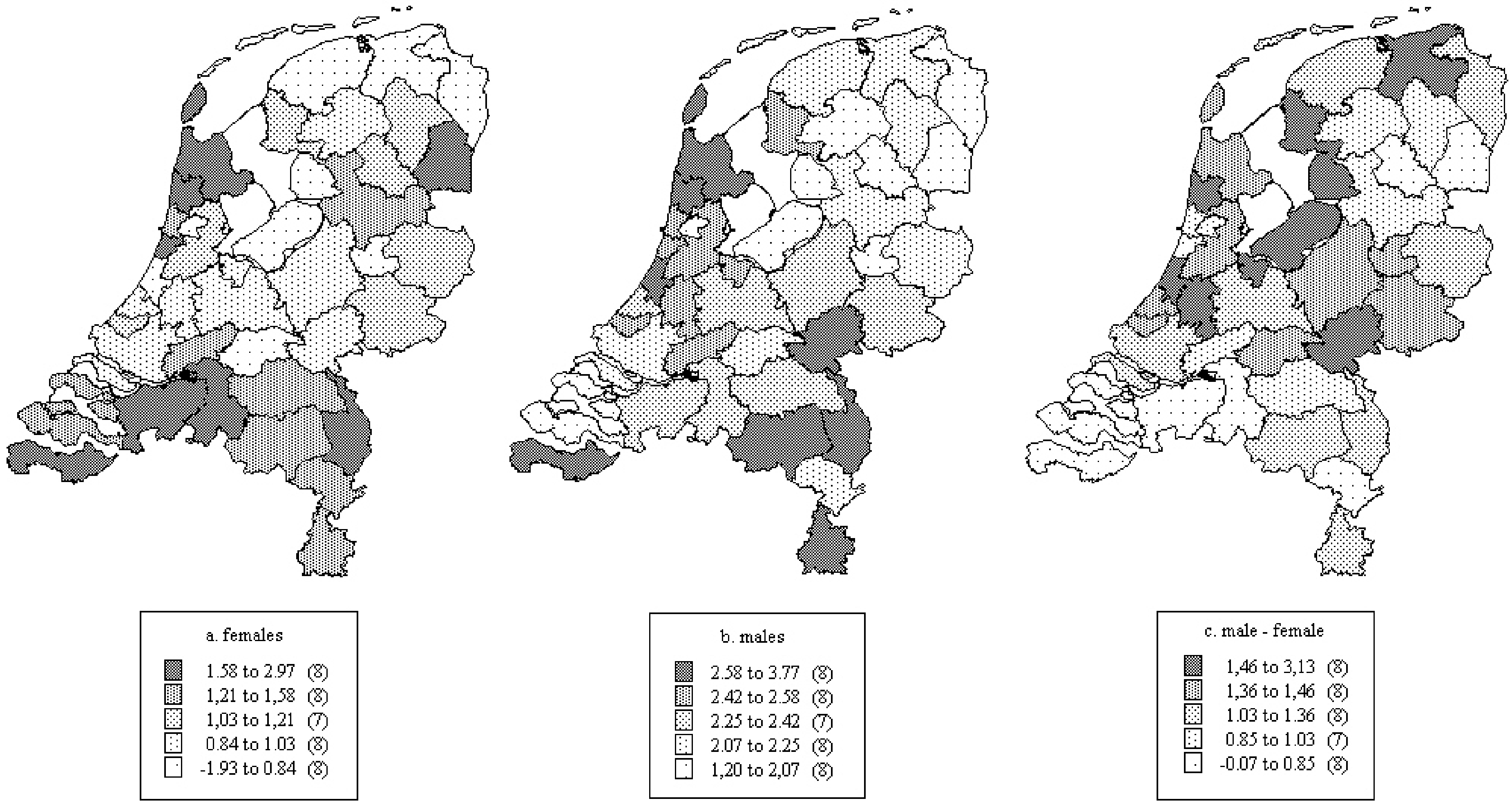
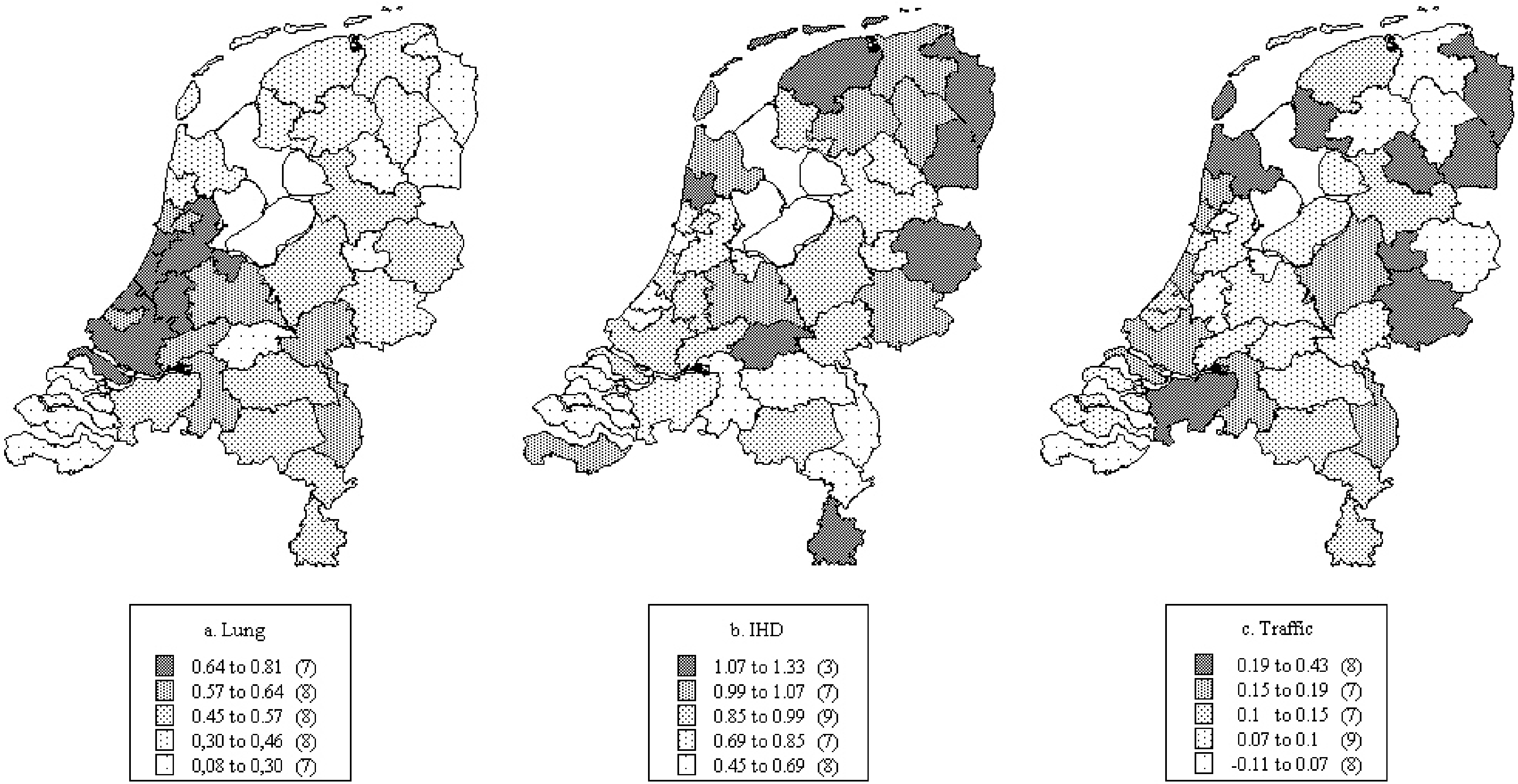


Figure 7.5 Declines in the sex difference in life expectancy at birth between 1980-83 and 1996-99 due to lung cancer, IHD and traffic accidents in 38 Dutch regions



International evidence to support the argument that a decline in the sex gap in mortality coincides with a change in the mortality ratio between men and women is mixed (Waldron, 2000), but the evidence presented here for the Netherlands does suggest that the mortality rate ratios are in fact converging, especially for lung cancer, but also for total *mortality (Table 7.10*). Moreover, a regional differentiation was evident: in 1980-83, the lung cancer mortality ratio of men to women, among 45-74 year olds, was less than 10:1 in some of the most 'gender equal' regions in the Randstad, compared to a ratio of more than 20:1 in several northern regions. By 1996-99, the extremes had been reduced to between 2.2:1 and 5.5:1, but the regional pattern remained. Although there was some regional differentiation in the sex mortality ratio for traffic accidents during both periods, overall there was no decline.

Table 7.10 Male to female standardised mortality rate ratios in the Netherlands for all causes, lung cancer, IHD and traffic accidents, and regional maxima and minima, 1980-83 and 1996-99

	All causes (ages 45-74)			Lung cancer (ages 45-74)			IHD (ages 45-74)			Traffic (all ages)		
	ratio	max	Min	ratio	max	min	ratio	max	min	ratio	max	min
1980-83	2.0	2.1	1.8	11.6	23.2	7.8	2.9	3.4	2.0	2.7	4.2	1.7
1996-99	1.7	1.9	1.5	3.3	5.5	2.2	2.6	3.0	2.1	2.7	5.2	1.8

7.7. Regional variations in male-female mortality differences in the 1980-83 and 1996-99 cross-sections: a multivariate analysis

A brief description is given below of the results of the analysis that seeks to establish if the variation and decline in male-female mortality differences can be explained by the variables that were selected to test the hypothesis developed by Waldron. In the discussion section, a more in-depth interpretation is given of the results.

Total mortality

The first of Waldron's causal hypotheses proposed that gender differences in cigarette smoking would result in sex differences in mortality. However, the multivariate results showed that the smoking variable, a measure of the difference between male and female smoking levels, did not contribute in any way to male excess mortality between the ages of 45 and 74 for the period 1980-83 (*Table 7.11*), albeit only after controlling for wages and deprivation. More support was given to the Labour Force Participation Hypothesis, as gender differences in unemployment were statistically significant at the 10% level. The gender roles modernisation variables (divorce and TFR) did not contribute to the explanation. Conversely, the main driving force behind the sex differences in total mortality in 1996-99 was TFR, although the relationship was in the opposite direction than anticipated, as the gender-specific analyses indicated that higher fertility levels protected male rather than female health. The variables did explain 31%, or about twice as much as in the earlier period, of the regional sex differences in mortality.

Table 7.11 Outcomes of the regression analysis[1] of associations between various types of determinants and male-female differences in all-cause and cause-specific mortality, 1980-83, 1996-99 and between the two periods

	ages 45-74 Total	ages 45-74 IHD	ages 45-74 Lung	all ages Traffic 1	all ages Traffic 2
			1980-83		
(Constant)	7.29 ***	3.53 *	1.31 *	1.01	
dSMOK (x 1000)	-0.04	0.03	-0.05		
CARS (x 100)				1.50	
dPART (x 100)	-1.42	0.93	-1.58 ***	0.50	
dUNEMP (x 100)	8.43 *	3.25	0.61	0.90	
TFR	0.00	-0.12	0.11	0.22	
dDIVOR (x 100)	15.23	9.74	11.98 **	5.94	
WAGES (x 100000)	-8.76	-7.56	1.37	-6.24 **	
DEPRIV (x 100)	-0.64	1.34	-2.20 *	-0.86	
% of variance explained	15	8	34	51	
			1996-99		
(Constant)	7.16 ***	1.60 **	1.39 **	-0.15	0.13
dSMOK (x 1000)	0.47	0.22	-0.17		
CARS (x 100)				1.62 ***	1.27 **
dLICEN (x 100)					-0.79
dDISTAN (x 100)					0.15
dPART (x 100)	3.23	-0.14	-0.39	-0.31	-0.04
dUNEMP (x 100)	8.13	-2.50	0.19	-0.34	-0.91
TFR	-1.58 ***	-0.45 **	0.03	0.29 **	0.24 *
dDIVOR (x 100)	2.55	3.67	10.72 **	2.55	1.13
WAGES (x 100000)	-6.41	-0.21	-1.23	-1.47	-1.61
DEPRIV (x 100)	-1.31	0.40	-1.73 *	-0.33	-0.01
% of variance explained	31	16	48	41	41
			1996-99 - 1980-83		
(Constant)	-1.59	0.44	-0.45	-0.26	
average 80-83 & 96-99	0.24	-0.80 ***	0.15	-0.52 *	
dSMOK (x 1000)	2.86	2.74	-1.59		
CARS (x 100)				7.78	
dPART (x 100)	0.13	1.24 *	-1.43 **	-0.35	
dUNEMP (x 100)	8.27	0.98	-1.17	-1.05	
TFR	0.37	0.63 *	-0.07	0.07	
dDIVOR (x 100)	20.56	15.60 **	9.61	9.18	
WAGES (x 100000)	-1.56	0.49	-2.23	2.05	
DEPRIV (x 100)	0.85	0.99	-0.76	-0.61	
% of variance explained	0	45	22	0	

[1] *From multiple regression analysis of the differences in male and female mortality, expressed in years of life expectancy for the three types of determinants: smoking (or traffic variables in the case of transport accidents), labour force participation variables and gender roles modernisation variables. N = 38 regions, * P < 0.10; ** P < 0.05; *** P < 0.01.*

Lung cancer

In both periods, regional gender differences in smoking habits were not in any way responsible for the regional sex differences in lung cancer rates. Rather, the 1980-83 data showed that gender differences in labour force participation was a significant factor, but the sign of the coefficient was the opposite to what was expected. Mortality differences were largest in regions with relatively small gender differences in labour force participation, perhaps because labour force participation appears to be detrimental to the health of women and protective towards men as can be seen in Table 7.7. Of the gender roles modernisation variables, divorce contributed significantly to the explanation. The association was positive, i.e. in regions where the excess proportion of divorced women relative to men was clearly above average, the level of excess male lung cancer mortality was generally low. The context variable 'deprivation' also proved significant: higher levels of deprivation were associated with lower sex differences in lung cancer mortality. The 1996-99 results were similar, except now the Labour Force Participation Hypothesis was rejected. The percentage of the variance explained by all the variables considered was 48% compared to 34% in 1980-83.

Ischaemic heart disease

With respect to the earlier period, smoking again explained only little of the regional sex differences in mortality. In fact, none of the variables, including the contextual ones, were significant and just 8% of the regional sex differences in mortality could be explained. In 1996-99, the situation was only slightly different. The first two hypotheses were rejected, and the adjusted R^2 equalled just 0.16 when all the variables were included, but the TFR was a factor in the male-female differences in IHD mortality. The association was negative, as was the case for total mortality, and so it appears that fertility levels are not associated with female IHD mortality levels, but rather that there is a negative association with male mortality, i.e. changing female gender roles appears to be more detrimental to the health of men.

Traffic accidents

In the analysis of traffic accidents, mortality at all ages was included, as sex differences were particularly noticeable below the age of 45. The main independent variable used was the number of cars per capita. The results for the 1980-83 regression analysis showed that the Reduction in Protection Hypothesis did not hold as the regions with more cars did not have smaller gaps in male-female mortality from fatal traffic accidents. Only the context variable 'wages' contributed to sex differences in traffic mortality although, when the TFR variable was excluded from the model, the labour force participation variable became significant. Unlike in the earlier period, the 1996-99 results clearly showed the importance of the number of cars per capita in explaining the sex differences in traffic accident mortality. In theory, however, the other two traffic variables included in this analysis, gender differences in average daily distance travelled and gender differences in holding a driver's licence, should have had more explanatory power, but these proved to be insignificant. Rather, cars per capita appeared to be the best proxy for road exposure differences between men and women, even though it was not sex-specific (although more cars do imply more female road users). The probable explanation is that the two gender-specific traffic variables were insufficiently different across regions to contribute to the explanation. The gender roles modernisation variable TFR was the only other significant factor. In other words, regions with a high TFR experienced a larger sex gap in traffic accident mortality.

To summarise, the two periods clearly differed in the types of variables that contributed to the explanation of regional differences in male-female mortality. During the most recent period, the Gender Roles Modernisation Hypothesis could not be rejected for any cause-of-death category. Either TFR had a negative association, or divorce a positive association, with gender differences. In comparison, results for 1980-83 were more ambivalent. The labour force participation variables appeared to be most important, as they were significant in explaining regional male-female differences in total mortality and lung cancer. The Gender Roles Modernisation Hypothesis was only accepted in terms of lung cancer. With respect to IHD and traffic accidents, all the hypotheses were rejected. Further, the Smoking Hypothesis was not upheld in any of the analyses.

7.8 The decline in male-female mortality differences between 1980-83 and 1996-99

The results of the analysis of changing regional gender inequalities over time showed that, once all the variables were included, the variance of the regression analysis that could be best explained was for IHD (R^2 of 0.45). In the IHD analysis, the Smoking Hypothesis again did not hold, but the decline in the male-female mortality gap was partly associated with declines in gender differences in labour force participation (Table 7.11). Further, both gender roles modernisation variables were significant. The smoking variable was also not significant in the lung cancer model. Instead, contrary to the proposed theory, regions with the largest declines in sex differences in lung cancer mortality were those with the least convergence of male-female labour force participation rates. The sex-specific time-difference analysis, in Section 7.5, revealed that regional labour force participation rate increases were associated with *lower* male lung cancer mortality. The analysis of total mortality and traffic accident mortality showed no significant contribution from any of the variables to the decline in male-female differences.

To remove the possible effect of regression towards the mean, the average sex difference in life expectancy in both periods was also included in the model. This factor was negatively significant in terms of both IHD and traffic accident mortality, which indicates that the larger the average sex difference, the greater the decline in male-female mortality differences. None of the variables were significant without this additional factor.

Additional information on possible causes of the decline in male-female mortality differences was extracted by comparing the coefficients for each period. For example, there was a significant decrease in the values of the TFR coefficients related to total and IHD mortality. In the 1996-99 period, the regions with the highest fertility levels (i.e. more women fulfilling traditional gender roles) recorded the lowest differences in mortality whereas, in the earlier period, TFR played no part at all. Divorce and deprivation were about equally important in explaining the sex differences in lung cancer mortality in both periods.

7.9 Discussion

This study has focussed on two specific periods, 1980-83 and 1996-99, and the changes that occurred between them. Over this period, the sex gap in mortality declined in the Netherlands by 1.2 years, ranging from -0.1 years in Zeeuws-Vlaanderen to 2.0 years in and around Leiden. The 45-74 age group was particularly responsible for the narrowing of this difference, with male-female mortality differences actually increasing beyond the age of 75. IHD and lung cancer were the two causes of death primarily responsible for the decline. Although sex differences in IHD mortality in the north-east continued to lag behind those regions which are considered to be the cultural and economic centre of the country (i.e. the Randstad) during the latter period, they did show the largest decline in both the absolute and the relative male-female mortality gap. In other words, not only was there a catching-up effect from the late 1970s in terms of absolute IHD mortality in the Netherlands by the "peripheral regions", as had been earlier observed by Mackenbach *et al.* (1990), but also a similar diffusion process has occurred in terms of differences between the sexes. This does not apply to the southern regions where the male:female standardised mortality sex-ratios were the lowest in both periods and actually increased over time. Turning to lung cancer mortality, absolute sex differences declined everywhere between 1980-83 and 1996-99, but clearly the fastest in the Randstad region. Regional variations in the decline in the mortality sex ratio were less apparent. For instance, the same drop was observed in Amsterdam as in the country as a whole (72%) even though Amsterdam had the lowest sex ratio in the country during both periods.

There are two conclusions that can be drawn from the results of the decomposition method. Firstly, although a decline in the male-female gap in life expectancy can coincide with similar proportional gains in survival because men have a lower life expectancy, this does not apply to each cause of death, in particular when the population exposure to important risk factors is strongly affected by social norms. Secondly, the persisting regional differences in mortality sex ratios indicate that, while the gender gap in certain exposures is declining, regional differentiation in social norms remains.

Unfortunately, it was not possible to provide an overall explanation or hypothesis of the trends in sex differences in mortality that would synthesise all these findings, as the causation proved to be quite complex. The fact that the Smoking Hypothesis could not be proven is somewhat of a surprise, but there are several possible explanations for this. It could be that the regional gender differences in smoking were not large enough to make a significant contribution to the explanation of sex mortality differences, but it might also be because a relatively short time lag was considered and that this was insufficient to capture the important influence of smoking on mortality. Other research has indicated that a substantial decline in smoking levels would lead to a decline in IHD mortality approximately 15 years later, while for lung cancer the delay would be approximately 30 years (Ruwaard and Kramers, 1993). Unfortunately, regional level smoking data were not available for an earlier period and, further, the smoking data were not age-specific and did not take into account smoking intensity differences between men and women (Kunst *et al.*, 1993).

There was, however, more support for the other hypotheses. In the cross-sectional analyses, the Gender Roles Modernisation hypothesis could not be rejected in any of the models for the period 1996-99. A possible change in pathways could be implied, as the labour force participation variables showed no association with sex mortality differences during this period although, in 1980-83, they had performed slightly better than the gender roles variables. Over time, the decline in the gender difference in both these types of variables could only be associated with a reduced male-female gap in terms of IHD.

When comparing the two types of analyses employed, the cross-sectional analyses explained greater proportions of the variance than the dynamic analyses, with the exception of IHD. One possible explanation is that the pattern of mortality and the regional differences in the position of men and women changed only slightly over time. In such a situation, in order to establish determinants of the decline in the male-female mortality gap, it would seem preferable to use a cross-sectional approach, and compare the various types of determinants between different periods.

A final comment about the results is that one should not dismiss the importance of the ‘wages’ and ‘deprivation’ context variables. On three occasions, one of these two variables was significant. There was a negative association between wages and traffic accident mortality differences between men and women, perhaps because wealthier regions will contain more cars and, in particular, second cars are more likely to be driven by women. In both time periods, deprivation appeared to be more disadvantageous for women in terms of lung cancer. A tentative explanation is that, unlike with men, the prevalence of ‘ever smokers’ (i.e. current or past smokers) among lowly educated women of middle age is less than among better educated women (Cavelaars, 1998) who are, at the same time, less likely to reside in deprived areas.

By comparing associations in the male-female differences analyses with the sex-specific results, one could validate the results and this showed that the suggested associations of some of the studied changes in the positions of the sexes were different for men and women. This was the case for one of the gender roles modernisation indicators, TFR, where one could expect fertility to be negatively associated with female mortality (the contribution of maternal mortality was considered to be insignificant), and therefore positively associated with the male-female mortality gap. However, no association was found in the 1980-83 analysis. The results for 1996-99 even revealed that TFR was associated with a lower male-female gap in total mortality and in IHD mortality. Given that, at the sex-specific level, there was a negative association between fertility and mortality among men and no association among women, one may tentatively conclude that in those regions with more traditional households that the men retain some of the protection offered by traditional gender roles.

A second example of a gender difference in the association between a variable and mortality relates to the Labour Force Participation Hypothesis. The sex-specific results for lung cancer in the first period studied revealed that, when average female labour force participation rates were still low, its association with labour force participation was in opposite directions for women and for men, since, without controlling for other variables, regions with high levels of female labour force participation tended to have high levels of female lung cancer mortality. While this is in accord with Waldron's theory, the results for men were the opposite. This can, however, be explained by other factors. For example, according to Elstad (1996), there are also benefits to be gained from participating in the labour force, such as having a larger social network, more opportunities for self-actualisation and a feeling of power and self-confidence from having a job and an income. In our sex-specific results, these benefits apparently outweighed the negative effects on men of participating in the labour force, but not so for women. This may be because in relatively gender-equal countries, such as the Netherlands, women's life expectancy may have suffered as employed women are more likely to smoke and partake in other health-damaging behaviour and thus negating the benefits of participating in the labour force (Nathanson, 1995).

Although this geographical study has provided a good opportunity to study the association of changes in the position of the sexes and mortality, it nonetheless has had some serious limitations. One problem with ecological studies is the general one of establishing associations that may not be consistent over time or space. Much disease-related mortality is the result of an accumulation of exposures across the life course (Davey Smith, 1997). Potential effects of indicators such as unemployment, divorce and smoking on mortality thus depend on the duration and time of the exposure. The fact that sex differences in mortality in the Netherlands were largest in the early 1980s does not imply that gender differences in factors that affect mortality were also largest in this period. Incorporating time lags might therefore be a sound approach in ecological studies. With the exception of smoking, this was not done in this study, as the necessary data for earlier periods were not available. Considering the unexpected results for smoking, given the generally accepted fact that smoking causes about 90% of lung cancer deaths, it would seem that the data and/or the methodology used have room for improvement.

Additionally, had data on gender differences in amount of driving and number of driving licences for the earlier period been available, this might have improved the explanation of sex differences in traffic accident mortality. This argument could equally be applied to other causes of death: no detailed data existed on sex-specific socioeconomic status variables such as political power (proportion of women in government at various levels), income, labour force participation in terms of hours worked and changing dietary patterns, including the consumption of alcohol.